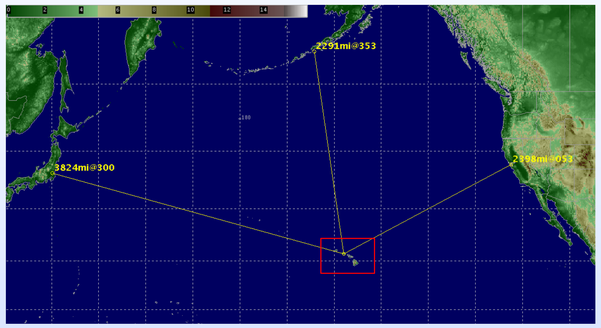
Subtropical and Tropical Frontal Passages: A Hawai`i Perspective

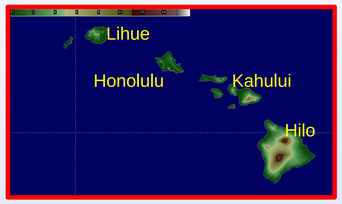
Jordan J. Gerth
Cooperative Institute for Meteorological Satellite Studies (CIMSS)
Space Science and Engineering Center (SSEC)
University of Wisconsin at Madison

Eric K. Lau
Environmental Scientific and Services Division
National Weather Service (NWS) - Pacific Region HQ
National Oceanic and Atmospheric Administration (NOAA)

Geography of Hawai`i



Four Hawai`i observation sites



Frontal Passages

Criteria

- Wind direction shift of 50 degrees or more over 2 hours.
- Temperature change of at least 5 degrees Fahrenheit over 2 hours.
- Sustained winds of 9 knots for one of the three observations.

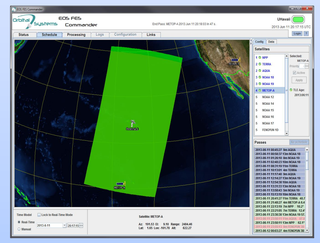
Challenge

- True definition of frontal passage is subtle
  - Post frontal southerly winds.
  - Diurnal effects - frontal passage occurring around sunset.
  - Mesoscale processes - post frontal rain showers.

Direct Readout Reception

L/X-Band Polar Orbiting Satellite Tracking Antenna

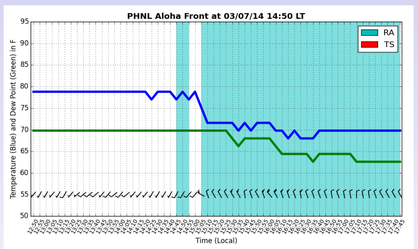
- Suomi NPP
- Aqua
- Terra
- NOAA POES
- METOP
- Fengyun (風雲)

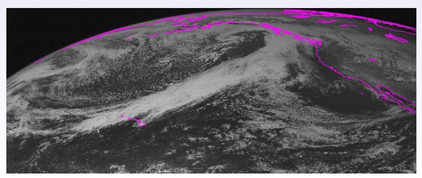


In collaboration with
NESDIS JPSS, GOES-R, University of Wisconsin, University of Hawai`I, and National Weather Service

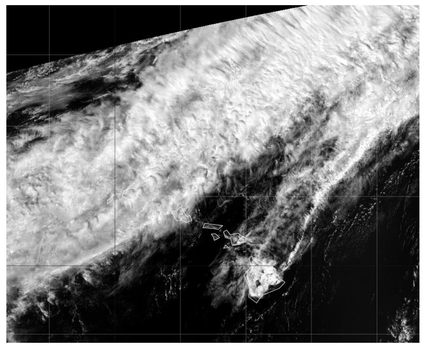
Cases of frontal passages across Hawai`i

March 7, 2014



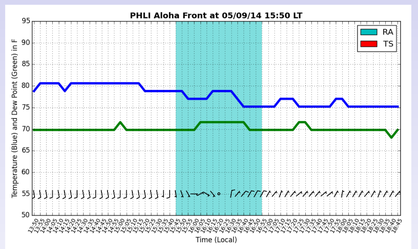


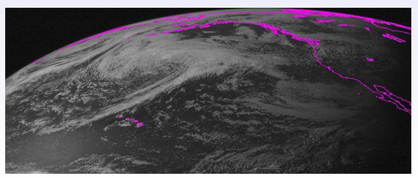
GOES-15 Imager 0.64 µm visible
March 7, 2014 1:30 pm HST



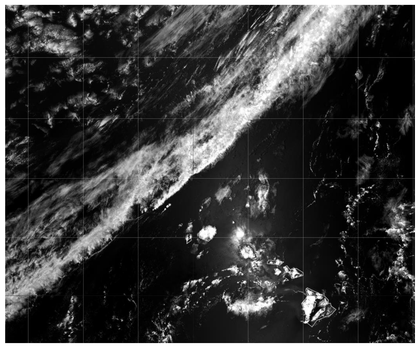
Suomi NPP VIIRS Day Night Band
March 7, 2014 1:14 pm HST

May 9, 2014



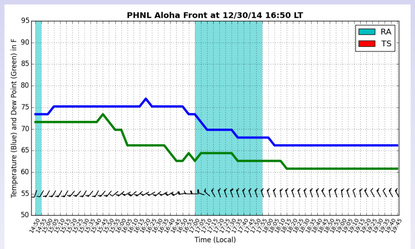


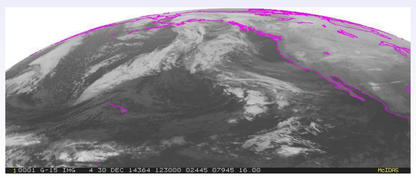
GOES-15 Imager 0.64 µm visible
May 9, 2014 4:00 pm HST



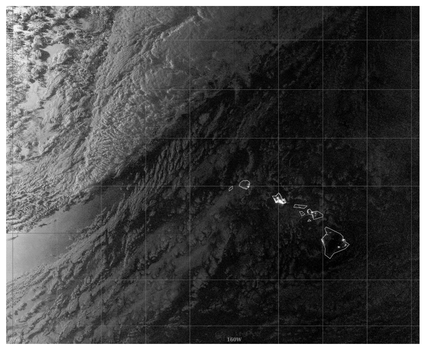
Suomi NPP VIIRS Day Night Band
May 9, 2014 1:34 pm HST

December 30, 2014



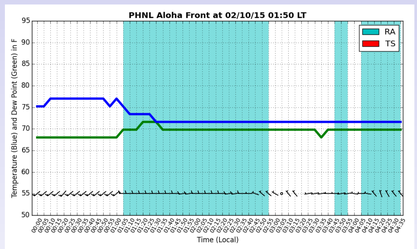


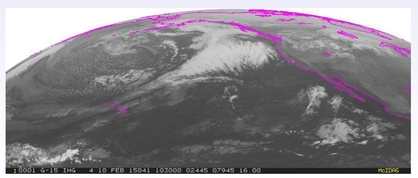
GOES-15 Imager 10.7 µm IR window
December 30, 2014 2:30 am HST



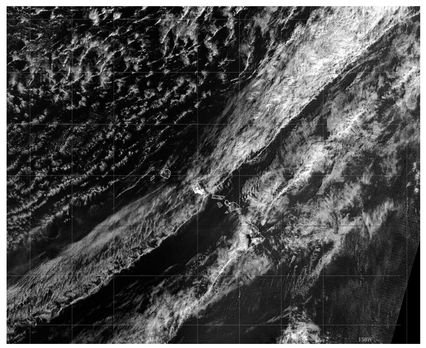
Suomi NPP VIIRS Day Night Band
December 30, 2014 2:18 am HST

February 10, 2015





GOES-15 Imager 10.7 µm IR window
February 10, 2015 12:30 am HST



Suomi NPP VIIRS Day Night Band
February 10, 2015 12:30 am HST

Frontogenesis

$$F_H = \frac{D}{Dt}\nabla_H\theta = \frac{D}{Dt}\left(\frac{-\partial\theta}{\partial y}\right)$$

$$= \left(\frac{\partial\theta}{\partial y}\right)\left(\frac{\partial v}{\partial y}\right) + \left(\frac{\partial\theta}{\partial z}\right)\left(\frac{\partial w}{\partial y}\right) - \left(\frac{\partial}{\partial y}\frac{\partial\dot{\theta}}{\partial y}\right)$$

Confluence Tilting Diabatic

Conclusion

- Often times, frontal passages across Hawai`i are very weak, especially over the eastern portion of the Hawaiian Island chain.
- The true definition of a frontal passage may not be met despite satellite observed cloud features.
- Polar orbiting satellites data provide added value when used in conjunction with geostationary satellite data.
- The Suomi NPP VIIRS Day Night Band provides visible at night in the absence of GOES-15.